GENERAL NOTES.

The Carnegie Institution.—The report of President WOODWARD of the Carnegie Institution for the fiscal year ending October 31, 1905, was reprinted in *Science* of January 26th. Of the $435,000 appropriated for works of investigation, it is worth noting that $168,000, or 38 per cent of the whole, was apportioned to astronomical researches. Most of this was for the establishment and equipment of the Solar Observatory on Mt. Wilson.

A portion of the report is given up by President WOODWARD to a discussion of "large *versus* small projects." He seems to have decided leanings toward the former, and it is noticed that an astronomical observatory in the southern hemisphere is one of the large projects now under contemplation.

The Harvard Five-Foot Reflector.—*Popular Astronomy* for March contains an article, from the Chicago *Record-Herald,* giving a description of the mounting at Harvard College Observatory of the 60-inch reflecting telescope recently purchased from the estate of Dr. COMMON, of England. Many new problems have been encountered in mounting such a large mirror,—it weighs nearly a ton,—and the results to be obtained with it will be awaited with interest. The tube which contains the mirror is attached by means of a fork to the upper end of a polar axis. This latter is an immense steel cylindrical float, 18 feet long and 7 feet 8 inches in diameter, supported on pivots in a concrete tank, and so ballasted that it will hang at the proper angle when the tank is filled with water. Nearly the entire weight of the telescope and the axis may thus be thrown onto the water.

The eye-piece of the telescope is to be located permanently in the second story of a building immediately adjacent to, and presumably north of, the tank, and the rays of light are to be brought to it through the use of a system of auxiliary mirrors, the idea being similar to that employed in the equatorial Coudé. "The idea of supporting the polar axis in a tank of water, as first put into effect and perhaps originated by Dr. COMMON, is an especially practical one, whose simplicity and

economy in mounting a large instrument are at once apparent. But a great advance over the crude hand machinery for moving and guiding the telescope in its former mounting is being made at Cambridge. Through inventions and devices, the result of much thought and experiment on the part of Mr. GERRISH, the telescope is to be controlled and operated entirely by electricity. Small switches located at the desk in the observing-room will control motors and clutches by means of which the telescope can be swung at various speeds. A small motor, synchronized by an accurate clock, will give a uniform motion for following, while dials and indicators, also in the observing-room, will show at a glance the exact position of the telescope and the motion which is being imparted to it. Thus, while sitting comfortably at a desk in a warm room, unexposed to the weather, the observer can carry on his investigations on the coldest winter night as easily as on the pleasantest summer evening."

This last statement is of course theoretically true, but those who have had experience with large telescopes will have some doubts about the quality of the "seeing" in these cold winter nights, especially as the observing-room appears, from the picture given in *Popular Astronomy,* to be heated by means of a stove. Much was expected from the equatorial Coudé when the idea of observing in a warm room was first put into practical form, but as a matter of fact the instrument has produced but few results, and that is the real test of any instrument, although failure to produce results cannot always be placed upon the instrument, as has been amply demonstrated in at least one instance during recent years. It is sincerely to be hoped that Professor PICKERING and his coworkers will be able to overcome all difficulties and attain abundant success in carrying out their plans for this immense telescope. S. D. T.

Double Variable Stars.—The following very interesting note by Professor S. I. BAILEY has been taken from *Science* for March 16, 1906:—

"Two interesting cases have recently been discovered by Mrs. FLEMING at the Harvard Observatory, of double stars, both of whose components are variable. That two variable

stars should be close together, where variables occur in large numbers, as in the dense globular clusters, or to a less degree in the Magellanic clouds, would not be especially surprising. Even here, however, as a matter of fact, very few really close doubles are found. In the sky as a whole, away from such special regions, the number of known variables in the 40,000 square degrees of the sky is not much more than 600, or one in 67 square degrees. The chance, therefore, that two of them should come within a few seconds of arc of each other, unless there is some physical connection between them, is extremely small.

"The first double-variable consists of the well-known variable star *S Lupi* and a close companion, distant only 13″, so close indeed that it may often have been mistaken for *S Lupi* itself, especially when it was bright and *S Lupi* faint. *S Lupi* has a period of 346 days, and varies in light about three and a half magnitudes, between 9.6 and 13.1. The close companion varies between 10.4 and 12.8, and its period appears to be irregular.

"Another variable pair has just been announced. The components are 40″ apart. The first component varies between the magnitudes 10.0 and 10.6, and the second between 10.0 and 12.4. It will be of the greatest interest to determine whether there is any relation between the light-changes of the components, but this has not yet been possible.

"It is well known to astronomers that Mrs. Fleming has discovered nearly two hundred variable stars by examination of photographic spectra, made with an objective prism, in connection with the work of the Henry Draper Memorial. By discovering that the spectra of long-period variables usually contain the bright lines due to hydrogen, she has been able to 'pick up' large numbers of variables of this class while engaged in other spectroscopic studies. It would have been quite impossible for a single observer, or perhaps for half a dozen, by visual methods, to find such a number in a lifetime. The results illustrate the power of photographic methods when the correct interpretation has been found. In this, as in some other lines of astronomical discovery, it would be almost a waste of time for an observer, unless for purposes

of recreation or amusement, to carry on the investigation visually. He would succeed about as well as a person who should attempt to race on foot with a fifty-horse-power automobile. This seems really a pity, as there is undoubtedly a greater charm, at least to the outsider, in the older methods. An observer, sitting at a desk with photographs about him, in a pleasant room in broad daylight, appeals to the imagination much less than the old-time astronomer, who was supposed to sit through the long cold night with his eye glued to his telescope. However, there are many fields in which the visual observer still has the advantage."

No. 4058 of the *Astronomische Nachrichten* contains a request by Herr BERBERICH, the newly appointed editor of the *Astronomicher Jahresbericht,* requesting that new publications be sent for review to his address, Berlin, Tempelhof, Schönburgstrasse 2.

A. N. No. 4061 contains a catalogue of thirty-nine newly discovered variable stars whose variability is regarded by the commission of the Astronomische Gesellschaft as established.

A. N. No. 4065: From the observatory at Moscow comes a report of the employment of photography in the measurement of double stars. A lens of 380^{mm} (15 inches) aperture and 6^{m} (20 feet) focal length was employed. Images of the double star were impressed upon the plate by exposures of from 1^{s}-30 to 1^{s}-70 duration. From 400 to 900 images were taken on a single plate. The orientation and scale value were determined by a trail, and by the distance between successive images made at measured intervals of time, the telescope being clamped and driving-clock stopped. Measures of the pair Υ *Virginis* (dist. $5''.8$) made on different plates agree to within about $0''.04$. The pair ξ *Ursae Majoris* (dist. $2''.6$) was also measured. It does not seem unreasonable to suppose that photography may in the near future lend important aid in the measurement of the wider doubles.

The Franklin Bicentenary.—The two-hundredth anniversary of the birth of BENJAMIN FRANKLIN will be appropriately celebrated on April 17th to April 20th next by the American Philosophical Society, Philadelphia, of which Dr.

FRANKLIN was founder. Besides the presentation of papers on scientific subjects there will be addresses by Professor E. L. NICHOLS, Professor ERNEST RUTHERFORD, Dr. H. H. FURNESS, President CHARLES W. ELIOT, Hon. JOSEPH H. CHOATE, and Hon. ELIHU ROOT. W. W. CAMPBELL.

A New Observatory in Hamburg, Germany.—It is announced that the city of Hamburg has appropriated 895,000 marks for the construction and equipment of an observatory under the direction of Professor SCHORR. A visual refractor of considerable size, a large reflector, a photographic refractor, and a meridian-circle are said to be in mind as the principal instruments. W. W. CAMPBELL.

Double-Star Work at the Flower Observatory.—It was my privilege some time ago to call attention in these *Publications* (Vol. XIV, pp. 106-109) to Professor ERIC DOOLITTLE's excellent double-star work with the 18-inch telescope of the Flower Observatory. It was apparent from the first volume of his measures that Professor DOOLITTLE brought to his work enthusiasm and energy as well as good judgment and keen observing powers. Fresh evidence of all these qualities is to be found in the more recent volume,[1] which contains measures of 1,066 double and multiple stars. Seven hundred and thirty-three of these stars are from BURNHAM's catalogue, 109 from OTTO STRUVE's, 102 from WILHELM STRUVE's, and the rest miscellaneous. In selecting these stars, Professor DOOLITTLE chose especially the "pairs of which there are few or no recent measures," and included also many that are in rapid motion or that have given some evidence of change. These stars "have been measured on an average of about five nights each," and very few on less than three nights. The observational data are conveniently arranged and critical notes are appended to many of the stars.

The volume bears very favorable testimony to the powers of the telescope and observer and to the atmospheric conditions prevailing at the Flower Observatory; for while the majority of the pairs measured are moderately easy, having distances

[1] 'Measures of 1066 Double and Multiple Stars Made with the Eighteen-inch Refractor of the Flower Astronomical Observatory," by ERIC DOOLITTLE.—Publications of the University of Pennsylvania, Astronomical Series, vol. III, Part III, 1905.

of from 1″ to 10″, and a considerable percentage are wide, still fully one fourth of the whole number are separated by 1″ or less, many of these pairs are quite unequal in magnitude and more than fifty are closer than 0″.5. The closest pairs successfully measured are *κ Pegasi, δ Equulei, and* β883. Such stars require "good seeing" for satisfactory measures with the largest telescopes. It is interesting to note that Professor DOOLITTLE's measures of the more difficult pairs are affected by much larger accidental errors in distance than in position-angle. Many of the pairs under 1″ show a range in distance of from 0″.25 to 0″.35, while the extreme range in position-angle rarely amounts to a linear displacement of 0″.1, and does not in general exceed 0″.05.

In the section on "The Method of Observing," in his introduction, Professor DOOLITTLE refers to the suggestion made in my review of his previous volume, that better results are likely to be obtained by measuring the position-angle with a single wire instead of with two separated by a few seconds of arc. Professor DOOLITTLE has experimented with the two methods, and finds that in his own case the first setting is nearer the true one if two wires are used. This is directly contrary to my experience, and, as it is a matter of practical interest to observers, it may not be amiss to point out once more the precise agreements and differences between the two methods.

We agree in discarding the slow-motion tangent-screw in measuring position-angles, and also in moving the whole micrometer-box longitudinally, making the wires pass back and forth over the stars till satisfied of the correctness of the setting. We are both also careful to keep the line joining the eyes either parallel or perpendicular to the line between the stars while making our measures.

But there are two points of difference in our practice that seem to me important. Professor DOOLITTLE apparently clamps the circle after making his first approximate setting, then moves the wires back and forth over the stars, and, finding the setting unsatisfactory, unclamps, changes it slightly, and repeats the process. My method differs in that the circle is never clamped, but is rotated slightly by the proper pinion,

making the angle alternately larger and smaller than the true value *simultaneously* with the longitudinal motion of the wires. Both motions are continued until a satisfactory setting is reached, the aim being to effect a direct bisection of the two star-images, not to get a line estimated to be parallel to their center line.

The other difference lies in the use of one wire instead of two in making our settings. In Volume V of the *Publications Lick Observatory* (p. 13) Professor HUSSEY, speaking of his measures of the OΣ stars, says: "All the settings for the determination of the position-angles have been made with a single wire, . . the other wire being placed so far from it as not to cause inconvenience or bias by its presence." I follow the same plan. We both find the close proximity of the second wire at least an inconvenience, especially in the case of close and unequal pairs, whereas Professor DOOLITTLE regards it as a distinct advantage.

Probably some physiological explanation must be sought for this fact as for the fact that some observers find it easier to make an accurate setting when the line between the eyes is placed perpendicularly to the line joining the stars than when it is placed parallel. R. G. AITKEN.

March 23, 1906.

Untersuchungen an den Spektren der helleren Gasnebel, von J. SCHEINER and J. WILSING.—This interesting paper of sixty pages forms a part of volume fifteen of the *Publications* of the Astrophysical Observatory at Potsdam. It treats of a subject which has received comparatively little attention since the classic work of Professor KEELER on the spectra of nebulæ (*Publ. L. O.*, Vol III, p. 165).

The lines of the present investigation follow closely those of KEELER in his determination of the radial velocities of fifteen of the bright nebulæ with the spectroscope of the Lick Observatory. Professors SCHEINER and WILSING have selected nine of the brighter nebulæ examined by him for their researches, the others being omitted on account of their low altitude at the latitude of Potsdam. The following is the list of nebulæ observed by them:—

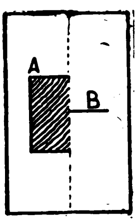
G. C. 4390	N. G. C. 7027	G. C. 4234	G. C. 4373
G. C. 4964	N. G. C. 6790	*Orion* (Tr.)	G. C. 4514
N. G. C. 6891			

A visual spectroscope mounted upon the Potsdam refractor was so designed that it could be used with slight changes for either of the following pieces of work which form the subject mater of the present article:—

I. A determination of the relative intensities of the principal lines in the spectra of the above nebulæ.

II. Measures of their velocities in the line of sight.

I. Relative intensities: For the investigation of the relative intensities of the three principal nebular lines the spectroscope was furnished with a 60° prism of fairly strong dispersion. A Zöllner photometer was so mounted on the spectroscope that the light from its lamp was thrown by a total reflection prism through one end of the slit and formed in the view telescope a spectrum alongside of that of the



nebula examined. In the focal plane of the observing telescope a diaphragm (see figure) was placed carrying two apertures, one of which (A) is large enough to admit the three nebular lines. The other slit (B), which falls upon the spectrum of the artificial light, is of the same width and length as the nebular line. In this way the color of the comparison light can be made exactly the same as that of the nebular line, a very important condition to be fulfilled in photometric work of this nature. As a source of light for comparison an incandescent lamp was used whose intensity was found to remain fairly constant for short intervals of time. However, to guard against any change in the lamp, it was compared at the beginning and end of each series of observations with a benzene lamp (of SCHEINER's design).

The method of observation was as follows: First, a comparison of the lamp with the benzene standard; then the slit B was shifted until it was in line with the principal nebular line, and the reading of the intensity circle of the photometer obtained, which rendered the intensity of B the same as that of the nebular line. Observations were made of the second and third nebular lines in a similar manner, then again of the

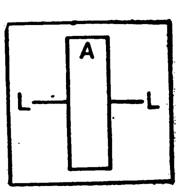
first line. Finally, a comparison of the lamp and standard was made.

Tables of the measures made by each observer, and the relative intensities of the second and third nebular lines referred to the principal line deduced therefrom, are given in full. Their observations confirm those of KEELER,—namely, that the relative brightness of the first and second nebular lines is within the limits of error of observation the same for all nebulæ examined, but the ratio of the intensities of the first and third line varies greatly for the different nebulæ. The actual intensites obtained depend, however, upon the distribution of energy in the spectrum of the artificial source. A comparison of the lamp with the benzene standard was made in order to determine the constants for reducing the measures to an absolute scale.

A table is here given of the nebulæ arranged in the order of intensity of the first nebular line (reduced to the benzene lamp), the intensity of the first line in the brightest nebula being taken as equal to magnitude 1.00.

Nebula.	Intensity of First Nebular Line.
G. C. 4390	$1^m.00$
N. G. C. 7027	1 .87
G. C. 4234	2 .07
G. C. 4373	2 .31
G. C. 4964	2 .68
N. G. C. 6790	2 .73
Orion (Tr.)	3 .26
G. C. 4514	3 .47
N. G. C. 6891	3 .90

II. Radial velocities: For the purpose of determining the velocities in the line of sight of the above nebulæ, the 60° prism was replaced by a Rowland plane grating, 36×49^{mm} ruled surface, and 14,438 lines to the inch. The third order of this grating was used in all measures. For setting on the lines a different arrangement was employed from the usual one. It evidently possesses so many merits that it is worthy of notice here. A diagram, furnished with



an aperture (A) to admit the spectrum of the nebula, and the slit (LL), through which the light from the photometer lamp passes, is carried along by the screw of the micrometer. The slit LL is used as the measuring-line,

and has the distinct advantages that it can be made of the same color, width, and intensity as the nebular line to be measured.

For the present investigation no attempt was made to determine the wave-length of the nebular lines, since with their apparatus $H\beta$ was too faint in many of the nebulæ to admit of its being measured with accuracy. The first line only has been used in their measures, and for its wave-length they have adopted, KEELER's value, λ 5007.05. The iron line, λ 5006.31, was used for the comparison lines, and all measures made with reference to it.

Full data of all measures and results with the mean error of each observer are given for the nine nebulæ. A comparison of their results with those of other observers is given in the following table:—

Nebula.	Wilsing and Scheiner.	Keeler.	Hartmann.	Wright.	Vogel and Eberhard.	Frost and Adams.
G. C. 4234	— 32	— 34	....	....	....	....
G. C. 4373	— 64	— 65	— 66	....	....	....
G. C. 4390	— 7	— 10	— 11	— 11	....	....
N. G. C. 6790	+ 40	+ 48	....	....	....	....
G. C. 4514	0	— 5	....	....	....	....
N. G. C. 6891	+ 40	+ 41	....	....	....	....
N. G. C. 7027	+ 17	+ 10	+ 5	+ 12	....	....
G. C. 4964	— 5	— 11	....	— 7	....	....
Orion	+ 15	+ 18	....	+ 16	+ 17	+ 18.5

They give as their mean error of observation $\pm$ 3.2^{km}, while that for KEELER's observations is about $\pm$ 3.9^{km}. It should be noticed, however, that the variations between their individual observations is much greater in general than in the corresponding observations of KEELER, the reason for which is found in the fact that his observations were made with a more powerful instrument and under more favorable conditions. The mean error has been made comparable with his by increasing the number of observations. Their results are in satisfactory agreement with those of KEELER and form a valuable confirmation of his work. J. H. MOORE.

The Sun's Heat.—Professor H. H. TURNER, in his lectures on astronomy to young people in London recently, gave them a demonstration of what the Sun's heat might be like by melt-

ing iron in a furnace before their eyes. This experiment he performed by the ignition of thermit, which, burning at a temperature of over 3,000 degrees, produced a heat which is about half that of the Sun; and, as an illustration, the flaming mass was a striking pendant to the examples of liquid-air submitted to the audience previously, as exemplifying the cold of the lunar night.—*From Daily Graphic.*

An Artificial Eclipse.—The last of the Christmas lectures which Professor H. H. TURNER has been delivering at the Royal Institution was perhaps the most fascinating of a fascinating series. Bit by bit the Savilian professor had lured his youthful audience on till he almost brought them to the point of making astronomical calculations for themselves; and the last two minutes of the closing hour was occupied by them in drawing a corona from the artificial one which was thrown on the screen. The corona, as the lecturer explained, was in many respects the be-all and end-all of a total eclipse of the Sun, from an astronomer's point of view, and the drawing which the Royal Institution's budding astronomers were asked to make (on squares of cardboard with a central black spot to mark the eclipsed Sun) were made under conditions as far as possible resembling those under which observers labored before photography was applied to the problem. Thus, for about five explanatory minutes, the shadow of the imitation Moon crept over the bright disk of the electric Sun on the screen, while Mr. HEATH made ready photographic plates, and Professor TURNER gave directions about the cœlostat. Then suddenly totality supervened. An image of the corona flashed out on the screen, and the director-in-chief of the eclipse observations began to count, one by one, the hundred and twenty seconds during which totality would last and the million-mile rays of the corona would be visible. As he counted the seconds a hundred hurried pencils scratched out in the faint light the idea of the corona which impressed itself on the retinas of two hundred young eyes. The last second was counted out; the last click of the photographic cœlostat was heard; the corona disappeared like a flash, and the rim of the bright Sun once again appeared on the screen. It was a magnificent object lesson, and the youthful audience could not have cheered

their astronomical guide, philosopher, and friend more heartily if he had provided them with a real eclipse. He had, at any rate, furnished them in his lecture with all the data by which they might prepare themselves to observe the English total solar eclipse which will occur some twenty-one years hence, and which for twenty-five seconds will show the corona to observers in Yorkshire, Lancashire, and North Wales. He explained the methods of calculating the times and paths of an eclipse; he described the many preparations made by an eclipse expedition; and as far as possible he enumerated the various problems connected with the corona. One of the curious facts connected with it appeared from the observations made of it during the eclipses of the last century to be that this great luminous radiation was greatest in extent at the Sun's equator at a period of minimum sun-spots. That, however, was an observation which needed much more confirmation. It was also necessary to find whether the corona changed its form quickly or not. This could only be ascertained correctly by photography. Some most beautiful photographs had been obtained of the corona at a previous eclipse by Mrs. MAUNDER; and Mr. and Mrs. MAUNDER on the occasion of last year's eclipse had gone to Labrador so as to photograph the corona at as large an interval of time as possible from the similar photographs taken as Assouan. But bad luck dogged the steps of these two observers and culminated in a cloudy eclipse day, so that the question of the rate of change of the corona was still unanswered. Other investigations which might answer the most important question—the nature of the coronal light—were those connected with its diminution of intensity as it receded from the Sun.. By an examination of the degree and extent of this diminution, an examination on which Professor TURNER is himself engaged, we might come to some conclusion as to whether the particles which gave the light were doing so by reflected light, or whether they were incandescent and were giving the light themselves.—*From Daily Graphic.*

Science for March 23d contains titles and synopses of forty-one papers upon astronomical subjects which were read at the meeting of the Astronomical and Astrophysical Society

of America, held in New York, December 28-30, 1905. The same number of *Science* contains also titles and synopses of eleven papers upon mathematical and astronomical subjects which were read before Section A of the American Association for the Advancement of Science, at the meeting held in New Orleans on December 30, 1905.
